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Contributions to the study on helminth fauna of Dillon Beach

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CONTRIBUTIONS

TO THE STUDY ON HELMINTH FAUNA

OF DILLON BEACH

By
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CONTRIBUTIONS TO STUDIES ON HELMINTH FAUNA OF DILLON BEACH

INTRODUCTION

Studies on trematodes of marine organisms of the Pacific Coast have been of a scattered and fragmentary nature. J.Stafford (1904) collected and described a number of trematodes from fishes of the north Pacific, but, in his historical survey, Manter (1926) fails to mention specifically any studies covering the waters south of Canada. More recently, in the United States, several contributions to the field have been made by Dr. John E. Guberlet at the University of Washington and at the College of the Pacific by Dr. Alden Noble, under whose guidance this study was made. James Park (1937) revised the genus Podocotyle and added eight new species from Dillon Beach,California. Descriptions of individual trematodes have been made by various other investigators.

The investigation covered by this paper was begun during the summer of 1946 at the Pacific Marine Station. A preliminary search for larval trematodes in littoral invertebrates during the month of July

proved negative. Large numbers of snails were examined, the majority of the species being Tegula funebralis, Litorina planaxis, Litorina scutelata, and Thais emarginata. Although the search for adult trematodes centered in marine fishes, other representatives of the fauna were examined also (table 1, p.30). The fishes which yielded large numbers of adults and developmental stages of trematodes, cestodes, nematodes, and acanthocephala were obtained from tide pools, along open beaches and from commercial fishermen. Fishes taken from schools, such as jack smelt (Atherinopsis californiensis) and viviparous perch or surf fish (Crossochir koelzi) were more heavily infected than isolated individuals. No such fishes were found to be wholly free from helminth infections (table 1, p.30).

TECHNIQUES AND PROCEDURES

Collecting Intermediate Hosts

The procedures used in collecting and studying snails were those developed and successfully employed by Fuhrman (1930). Three large or five small snails of the same species were placed in culture bowls with 200 ml. of water. The water was changed two days after the snails were placed

in it in order to get rid of fecal matter. Snails infected with motile cercaria are readily detected because of the milky appearance of the water imparted by the liberated organisms. After being observed for four or five days without feeding, the snails were dissected and examined for parasites.

Collecting Definitive Hosts

The fishes used in this investigation were obtained from three sources: rocky tide pools, shallow water off sandy beaches, and deeper water from the nets of commercial fishermen. Tide pools were usually productive of various species of sculpin, blenny, and immature specimens of cabezone. Small specimens were readily secured at low tide by turning over rocks, examining clumps of seaweed, or by means of a dip net. Some were blinded at night by an oxyacetylene lantern. The latter method was especially useful in sècuring fishes that normally go into hiding during the day or that rely on speed to escape capture.

Larger fishes were caught with ordinary fishing tackle such as is used by an experienced surf caster. Large blennies were caught with an apparatus consisting of a long, light pole, at one end of which was attached

two or three feet of stiff wire, carrying a very short length of cord and hook (plate 2, fig.3). At low tide, the hook, baited with abalone entrails, was thrust under an overhanging rock in search of a hiding fish. The stomachs of many individuals contained seaweed, small crustaceans, and young molluscs. The three fishes that were caught off sandy beaches were perch (Crossochir koelzi), jack smelt (Atherinopsis californiensis) and flounder (Platychthys stellatus). The flounders were found, oddly enough, in a shallow lagoon that was completely closed off from the ocean by a sand bar. Stemple Creek flows into this lagoon. The only salt water entering the lagoon must seep through the sand.

The sharks, angel (Squatina californica), leopard (Triakis semifasciatum), and brown smooth hound (Rhinotriacis henlei); sole (unidentified); and a large cabezone (Scorpaenichthys marmorata) were secured from commercial fishermen. Commercially useless angel sharks formed the greater part of the catch. None of those examined yielded a single helminth. On the skin surface of a large cabezone was found a number of parasitic copepods. Another species of copepods was attached to the gills of a leopard shark (Triakis semifasciatum) and a

third to the angles of the fins. Five leeches were found attached near the cloacal opening of a brown smooth hound shark (Rhinotriacis henlei).

Methods Used in Collecting Trematodes from Fishes

Monogenetic trematodes were found in the cloacal openings, in the angles of the fins, in the mouth and on the gills. All of the external trematodes found in this study were on the gills of either a leopard shark (Triakis semifasciatum) or a jack smelt (Atherinopsis californiensis). The worms were removed by scraping the surface of the gills with a sharp scalpel.

The procedure used in removing helminths from the alimentary tract was as follows. The oesophagus was severed as far toward the mouth as possible and the large intestine was severed near the anal opening. The whole intestinal tract was then placed in a pan of sea water. The oesophagus, stomach, small intestine and large intestine were successively slit open and scraped under water with a scalpel and then examined under a dissecting microscope to locate any worms that might not have been dislodged. The water in the bowl was decanted very slowly to remove food and mucous material, refilled with fresh sea water and decanted again. This process

was repeated until the water was clear. The helminths were located with the aid of a dissecting microscope and transferred to a Syracuse watch glass with a medicine dropper.

As each fish was dissected it was tagged with a small label. The number on the label corresponded to that on an index filing card which contained information as to date, kind of fish, number of helminths, kind of helminths and site of infection. Later, fishes of coubtful species were identified by Dr. Rolf Bolin, Dr. George Myers, and Mr. Fred Tarp of Stanford University.

Fixing Helminths for Study

The helminths were fixed in Lavdowsky's mixture of formalin, alcohol and acetic acid. Nematodes were dropped directly into the fixing medium but cestodes and trematodes were first flattened between glass plates. Small trematodes were placed on 1x3 inch microscope slides in a drop of sea water and covered with a micro cover glass. The fixing solution was introduced around the edges of the cover glass with a medicine dropper. Five minutes leter the glass was raised

and the worms were flooded with fixing solution. After an additional five minutes, the cover glass was removed and the trematodes were moved carefully to one corner of the slide with the edge of a piece of paper. They were then washed off into a vial containing fixing solution. In the case of large trematodes and short cestodes pressing between two 1x3 microscope slides proved satisfactory. For long cestodes and very thick, tough trematodes two pieces of thin window glass of convenient size were used with good results. When possible, the worms were fixed for five minutes individually and observed during the process under a pair of dissecting binoculars or a low power microscope to make sure that they are properly flattened.

Storage of Helminths Pending Staining

Helminths that were not to be stained and mounted immediately were washed in tap water to remove the fixing solution. The water was changed three times at fifteen minute intervals. They were then dehydrated through a series of graded alcohol baths in ten per cent steps, being left in each grade ten to fifteen minutes, and were finally stored in a mixture of 90

parts alcohol and 10 parts of glycerine. Before staining, stored helminths were run down a similar alcohol series to water.

Staining Techniques

Whole mounts were made of the trematodes using both Henneguy's Acid Carmine and Lynch's Borax Carmine. The latter method proved decidedly superior. The red colors were often brilliant and the contrast between the stained organs and the parenchyma marked. Considerable variation was noted in the coloration of worms of the same species from different fishes and even in individuals worms from the same fish. These variations may have been due to physiological differences. Several modifications of Lynch's method were tried out in order to determine: (1) whether the presence of the precipitated material is necessary in the second step of Lynch's original method or whether equally good results might be achieved by transferring the worms from the alkaline stain directly to the filtrate of the acidified stain; (2) whether the worms could be transferred directly from the alkaline stain into the destaining mixture of hydrochloric acid of 70%

alcohol (original B.C. method) and thus precipitate the carmine directly in the tissues (3) what the results might be if the worms were placed in a solution made by redissolving the precipitate of carmine in 70% alcohol and hydrochloric acid. In order to test the effects on more than one kind of trematode, three species were used in the experiment; 17 individuals of Genitocotyle acirrus, 2 of Otodistomum cestoides, 7 of hemiurids, and 1 of Helicometrina nimia (immature).

For the first test 4 hemiurids, 1 Genitocotyle acirrus, and 1 Otodistomum cestoides were placed in alkaline Borax Carmine stain for twenty four hours. They were then washed in tap water to remove excess stain and placed for an additional twenty four hours in the previously prepared filtrate of the stain that had been neutralized to the point of greatest precipitation with concentrated hydrochloric acid. On removal from the alkaline stain, the outer cuticles of the worms appeared whitish as if they had not absorbed much stain. On the inside each worm was purple. After being soaked in the filtrate of the stain, each worm turned a bright red. This experiment was repeated four times using a total of 3 hemiurids, 9 Genitocotyle acirrus and 1 Helicometrina nimia. The results

indicated that this method is equal to Lynch's original method. In this final test, 1 Helicometrina nimia, 2 hemiurids, and 4 Genitocotyle acirrus were bleached out after having been carefully destained to the proper degree and examined in toluene, then reprocessed by Lynch's original method. The results obtained in both cases were equally good.

For the second experiment, three separate tests were made, using 5 Genitocotyle acirrus and 1 hemiurid. The worms were transferred from the alkaline Borax Carmine directly to the destaining medium of 70% alcohol and hydrochloric acid (1 to 2 drops) per 25 cc. Here again the results were equal to those achieved by Lynch's original method.

In the final experiment 2 Genitocotyle acirrus were placed directly into the filtered precipitate of Borax Carmine in 25 cc. of 70% alcohol to which 40 drops of concentrated hydrochloric acid had been added. The results were decidedly inferior, the worms being stained a weak orange color.

Further experimentation will be necessary in order to establish the validity of these tests. Former procedures involved placing the specimens from the alkalized stain directly into the destaining medium with inferior results. It seems probable, however, that specimens can

be transferred effectively from the alkalixed stain to the neutralized filtrate of the precipitated stain, thus conserving stain which must be otherwise wasted by being precipitated about the specimens.

Mounting the Parasites

The nematodes and the cestodes scolices were mounted in glycerine jelly; the trematodes were mounted in Clarite. From one to four small worms, depending on the size of the cover glass, were placed on a 1x3 inch microscope slide. The weight of the acetabulum generally caused the worms to lie with the dorsal side up. A label was placed on each side of the cover glass. On the left hand label was recorded the date, number (corresponding to vial and index card), serial letter of each individual worm, family, genus, species, stain and mounting medium. The right hand label gave the scientific and common names of the host, the part of the host's body the worm came from, where the host was collected and the collector's name.

Photographic Equipment

The photomicrographic equipment used in this investigation consisted of a 4x5 View Graphic camera and

a Leitz microprojector with a 750 watt projection bulb (plate 2, fig. 1). The lens of the camera was removed and a board fitted in its place. The microprojector occular was fitted into an opening cut in the center of this board and the connections made light proof. Five opal glasses were found necessary to reduce the intensity of light during the exposure. The lower and medium power objectives of the microprojector were used, the light intensity being increased for medium power.

The equipment was used as follows: the specimen was clipped to the vertical stage, the opal glasses and cardboard removed and the projection lamp turned on. With a ten power magnifying glass held close to the ground glass the image was brought to as sharp a focus as possible. The lamp was turned off and the opal glasses were replaced. A test was made by exposing the whole negative for five seconds.

The slide of the plate holder was then partially returned for the second test exposure of five seconds; the holder was further returned for a series of exposures of ten seconds, twenty seconds and finally, forty seconds, the exposures being doubled after the first two. The exposures were made by turning on the lamp, raising

the cardboard and counting with a stop watch. When finished, the negative had the exposure pattern indicated below. From this negative the correct exposure time was determined.

5	5	5	5	5	seconds
	5	5	5	5	"
		10	10	10	"
			20	20	"
				40	"
5	10	20	40	80	"

Two kinds of film were used : "Panatomic X" with a film speed of Weston 32 which was found to require an average exposure of ten seconds, and "Portrait Pan" with a film speed of Weston 50 which required from five to eight seconds. The following trematodes were successfully photographed using this equipment and technique: Genitocotyle acirrus, Podocotyle elongata, Podocotyle californica, Helicometrina nimia, a monorchid, a hemiurid and a monogenetic trematode.

Since the field of vision of the microprojector was small it was necessary in four instances to photograph large worms by independent exposures of anterior and posterior halves. The negatives overlapped

in order to insure accurate juncture of the divided body by careful trimming.

For very large worms such as Otodistomum cestoides the above technique was found to be impracticable, They were photographed by transmitted light with a Speed Graphic camera. The microscopic slide containing the worm was fastened with masking tape into a window cut into a piece of cardboard. A fifteen watt lamp in a Kodak reflector was placed back of the cardboard (pl. 2, fig. 2). Difficulty was experienced in securing a sharp image even with the use of a ten power magnifying glass because of the low depth of focus. A test negative was made as described and the exposure times were found to be approximately the same as those for the microprojector. Trematode eggs proved troublesome by printing too darkly. This difficulty was overcome by painting them with Nucocine until they were of the same density as the surrounding tissues.

Photographic Enlarging

The worms were enlarged on 8x10, double weight "Kodakrome" N3 and N4 paper. N5 was tried but proved to be too contrasty. The letter N represents the type of surface which was adopted because of its ability to take a pencil. However, this surface did not take

India ink as well as expected. Certain spots on the paper acted as if coated with oil which caused the ink to form a line of small droplets. It was found necessary to burn in such structures as the oral sucker, acetabulum and the outer edge of the worm. Occasionally Dodging was resorted to in printing the eggs or vitellaria which required a much shorter exposure time than other parts. In general the enlargements of the worms were from five to seven inches long.

Photographing Trematodes in Color

The possibilities of using color transparencies in the study of trematodes was tentatively explained by photographing and processing a monorchid by the new Kodak "Ektachrome" process. The trematode was photographed through the photomicrographic equipment illustrated in pl. 2. Test negatives were made using ten second steps from 30 to 70 seconds and the proper exposure was found to be 50 seconds. Processing took one hour and a quarter. It will be noted that the background of the transparency is blue in color. This, undoubtedly, is due to the color of the light source or the color of the optical glass.

Drawing in Outlines in Pencil and Bleaching the Photographs

The outlines of the worms and of all structures in them were traced over the photographs with a hard (4H) pencil while details were checked against the original specimens under the microscope. The drawings were then bleached out in potassium ferrocyanide and hypo, leaving only the pencil lines. They were then washed for one hour in running water before being dried. It was found that a pale print bleached out completely while a dark print tended to have brown unbleached spots left on it.

Inking in with India Ink

The pencil lines of the trematodes were inked in with India ink, using a bent nose draughting pen for the outlines and a fine pointed drawing pen for the caeca, acetabulum, ovaries, testes, etc. As mentioned previously, the photographic paper used in this study did not take ink well with the result that the lines tended to be broken and uneven in width. It was necessary to touch up numerous places with pen and scraper. The organs were differentiated by using various patterns of stippling. Large stippling was used for testes. Fine stippling was used for the ovary and medium stippling for areas between

the organs. In the hemiurid it was necessary to stipple finely along the margins of the caeca in order to differentiate them from the excretory system. Vitellaria were made solid black and eggs were merely outlined. While the use of a camera eliminates the difficulties attending the use of photographic paper, it is slower and not as satisfactory when a large number of drawings are needed.

Library Procedures

In identifying the seven trematodes covered by this study, all pertinent references were located by a systematic search through the Biological Abstracts from 1937-1947. Material prior to that date was covered by Dr. Noble's files at the College of the Pacific. It was necessary to make a trip to the University of California Life Science Library to secure material on Otodistomum cestoides and the original work on Genitocotyle acirrus (Park,1937). Careful notes were made from these works and author's drawings were copied. Each trematode was checked against the original description. Five of the trematodes were definitely identified as Genitocotyle acirrus (Park), Otodistomum cestoides (Stafford), Helicometrina nimia (Linton), Podocotyle elongata(Park),

and Podocotyle californica (Park). Two, a monorchid and a hemiurid have not been identified at the time of this writing, but in the event that they prove to be new species a special report will be made on them.

DISCUSSION

Genitocotyle acirrus (Park, 1937)

Park found this trematode in the stomach and intestines of the perch Holconotus rhodoterus at Dillon Beach, California. The presence of a genital sucker and the absence of a cirrus or cirrus sac suggested the name. The genus Podocotyle which belongs to the family Allocreadiidae has the following characteristics: "elongated body medium size; no spines; oral sucker subterminal; ventral sucker larger than oral sucker; embedded in body, or pedunculated due to folds of the body wall; genital sucker present; cirrus sac absent; pars prostatica present; seminal vesicle tubular, elongated and coiled; testes smooth or lobed; coils of uterus intercaecal between acetabulum and ovary; seminal receptacle present; Laurer's canal present; eggs large, without filament; excretory pore terminal; excretory bladder simple; vitellaria largely lateral. Fish parasites." (Park,1937)

The worms of this study were found in the intestines and stomachs of three hosts. A sole (unidentified), 11 perch (Crossochir koelzi), and a zebra perch (Taeniotoca lateralis) (43). The perch, a viviparous species, were caught in the shallow water off the beaches at Dillon Beach and Stemple Creek, when they came in to deliver their young during July and August. The fact that remnants of small marine crustacea and several young limpets (Acmaea) and small snails (Tegula funebralis) were found in the stomach contents of the perch suggests that they might act as the intermediate hosts of the flukes.

The average dimensions of the worms obtained in this study were approximately the same as those given by Park except that they are smaller. This is natural since Park's specimens averaged 2.58(2.03-3.48)mm. in length, whereas the Dillon Beach specimens were 1.60 (1.15- 2.05)mm. These findings extend the size range of the species as well as add three new hosts to their habitats.

Helicometrina nimia (Linton, 1910)

The genus Helicometrina was added to the family Allocreadiidae by Linton (1910), who found the species

H. nimia in Neomaenus, Acyurus, Calamus, and Eupamocentrus. H.Parva was described by Manter (1933). The last species to be discovered, H. elongata, was described by Noble and Park (1933). It was taken from the intestine of the Gobiesocid fish, Caularchus meandricus. They found it necessary to amend the generic diagnosis as established by Linton.

The two specimens of Helicometrina nimia found during this investigation were taken from the intestine of a cabezone (Scorpaenichthys marmoratus), a new host. They differ from Linton's specimens in that they are larger, 4.16 mm. as compared with a range of 1.5-3.6 mm. Linton's specimens had ventral suckers 1.5 times the diameter of the acetabulum. Although the one found at Dillon Beach had a ventral sucker 2 times the diameter of the acetabulum, the discrepancy in size is regarded as an individual variation and not one to justify the designation of a new species.

Otodistomum cestoides (Van Beneden, 1871)

This parasite was first obtained by Van Beneden (1871) from Raia batis. Van Beneden gave it the name of Distomum cestoides. In 1904 Stafford found a trematode in the stomach of Raia stabuliforis to which he

gave the name Otodistomum veliporum. After careful study, Manter (1926) came to the conclusion that both O. veliporum and O. cestoides occur in North America and can be differentiated only on the basis of egg size. Van Cleave and Vaughn (1941), however, found eggs intermediate with Manter's measurements and concluded that there is just one highly variable species called O. cestoides which is found chiefly in the intestines of various species of Raia in both the Atlantic and Pacific Oceans.

Nine Otodistomum cestoides were obtained from the electric ray (Tetranarce californica) at Dillon Beach. In all previous hosts its location has been in the intestinal tract, but these specimens were located in the coelomic cavity between the stomach and the body wall. They ranged in size from 18 mm. to 30.5 mm. These dimensions compare favorably with Stafford's, their smaller size being due to immaturity. It is difficult to account for this newly discovered site of infection. The relative immaturity of the forms suggests the possibility that all members of the genus migrate through the coelom during some phase of their life cycle. Should this be the case, the search for intermediate hosts may be somewhat simplified.

Podocotyle elongata (Park,1937)

According to Odhner (1905) Distomum atomon Rud. is the type species for the genus which he redescribed and to which he gave the new name Podocotyle. Manter (1928) considers Sinistroporus simplex Rud. of Stafford (1904) and Distomum simplex Rud. of Levinson (1881) as synonomous with P. atomon. Park (1937) reviews the genus and lists the following species formerly described: : P. atomon Rud.(1802), P. reflexa (Creplin, 1825), P. olssoni (Odhner, 1905), P. syngnathi (Nicoll, 1913), P. penelli (Leiper and Atkinson, 1914), P. levenseni (I-saitschikov, 1928), P. pearsei (Manter, 1926), and P. lanceolata (Price,1934). Nicoll (1909) created a sub-species P. atomon var. dispar on the questionable basis of the arrangement of the vitellaria. Podocotyloides petalophallus (Yamaguti,1934) is included in the genus Podocotyle (Park, 1937).

Park added eight new species from the tide pool fishes of Dillon Beach, California: P. endophrysi,P. apodichthysi, P. blennicottusi, P. californica, P. kofoidi, P. elongata, P. pedunculata, and P. pacifica. He also revised the generic description as follows : Allocreadiinae; body elongated or elliptical in outline, dorso-ventrally flattened or cylindrical; cuticula smooth or ridged; ventral sucker larger than oral sucker;

oesophagus about twice as long as the pharynx at the most; excretory pore terminal or subterminal; excretory bladder elongated or clavate, extending anteriorly to the level of the middle of the posterior testis or beyond to the posterior edge of acetabulum; genital pore pre-acetabular, at left of body; cirrus sac elongated or clavate, extending to the anterior edge of or posterior to acetabulum; its anterior part protruded, protrusible, or not(?) protrusible; seminal vesicle straight, sinuous or coiled within cirrus sac; testes postmedian, smooth or lobed; ovary pre-testicular, smooth or lobed; seminal receptacle large; Laurer's canal present; coils of uterus intercaecal, between acetabulum and ovary; eggs without polar filament; vitellaria lateral, largely outercaecal, extending from the region of acetabulum to posterior end of body. Parasites of marine fishes. Type specimen: P. atomon (Rudolphi,1802)."

Park obtained specimens of P. elongata from the tide pool sculpins (Blennicotus globiceps). The single specimen of P. elongata found at Dillon Beach was obtained from the intestine of a small rock fish (Sebastodes paucispinus). Its size was astonishingly far below the range reported by Park. It is possible that, in spite of the fact that the presence of eggs indicated that the

specimen was mature, it was not fully grown. It seems more likely however, that open sea fishes like species of Sebastodes are not natural hosts of trematodes which attain such relatively large sizes in tide pool fishes. If subsequent investigations demonstrate the validity of this conclusion, a low degree of host parasite specificity will have been established for the trematode Podocotyle elongata.

Podocotyle californica (Park,1937)

One specimen, 1-2 mm. long, was obtained from the intestine of the perch or surf fish (Crossochir koelzi). Park secured his specimens from two sculpins of the species Blennicottus globiceps. They ranged in size from 2.18-3.85 mm. As in the case of P.elongata, the specimen of this study had the same proportions as those of Park, but it was smaller.

Hemiuridae (Luhe,1901)

A preliminary description of the species found in a blenny at Dillon Beach is as follows: body elongated, tapering anteriorly from the acetabulum and rounded posteriorly, 4.98(3.90-6.16) mm. long, 0.59(0.50-0.70)

mm.wide; oral sucker terminal, 0.16(0.15-0.18) mm.long, globular; prepharynx 0.19(0.16-0.20) mm.long, 0.13(0.10-0.15) mm. wide; oesophagus absent; caeca divide immediately back of the pharynx and extend into posterior end of body, diameter 0.09(0.05-0.15) mm., termination distance from posterior end 0.08(0.03-0.15) mm.; acetabulum 2.4 times size of oral sucker, in anterior fourth of body, 0.38(0.28-0.45) mm. in diameter; testes two, pear shaped, lateral, approximately 0.41 to 0.50 mm. apart, about equal in size, anterior testes 0.14(0.10-0.18) mm. by 0.25(0.20-0.33) mm.,posterior testes 0.19(0.13-0.33) mm. by 0.26(0.18-0.38) mm.; Ovary, oval to round, not lobed, in posterior third of body, 0.14(0.10-0.16) mm. long by 0.27(0.25-0.33) mm. wide; pars prostatica extending from seminal vesicle to acetabulum and continuing as a tube to the hermaphroditic duct where it is joined by the uterus; seminal receptacle just anterior to ovary and sometimes overlapped by it, oval to round, in center of body, 0.18(0.10-0.25) mm. long by 0.27(0.23-0.35) mm. wide; uterus in transverse coils from posterior limit of ovary to acetabulum and continuing as a fairly straight tube to the hermaphroditic duct; eggs small, not filamented, 0.033(0.26-0.045) mm. long by 0.013(0.011-0.019) mm. wide; vitelline follicles two,lateral, just posterior to

the ovary, oval; left follicle 0.20(0.15-0.28) mm. long by 0.27(0.23-0.30) mm. wide; right follicle 0.19(0.15 0.25) mm. long by 0.24(0.23-0.34) mm. wide; excretory vesicle clavate, dividing posterior to ovary and continuing laterally on each side to the oral sucker. Parasites of marine fish.

Monorchidae

Forty seven specimens comprising an as yet unidentified species were obtained from the intestines of five jack smelt (Atherinopsis californiensis).

A preliminary description of the species is as follows: body elongate, cylindrical, tapering anteriorly from acetabulum and rounded posteriorly, 3.13(1.36-5.00) mm. long, 0.75(0.51-1.05) mm. wide; oral sucker subterminal, larger than acetabulum, 0.32(0.28-0.35) mm., prepharynx 0.14(0.08-0.21) mm. long, 0.21(0.11-0.15) mm. wide; caeca divide immediately posterior to the pharynx, diameter 0.11(0.08-0.16) mm., termination distance from posterior end 0.09(0.05-0.11) mm.; acetabulum in anterior half of body, 1.14 times smaller than oral sucker, 0.28 (0.23-0.36) mm.; ovary, oval, not lobed, in anterior half of body, 0.34(0.23-0.41) mm. long, 0.35(0.25-0.46) mm. wide; testes single, oblong, large, at middle of body, 0.75 (0.53-0.88) mm. long, 0.37(0.31-0.50) mm. wide; cirrus sac

large, on a level with or just dorsal to the acetabulum, 0.53(0.43-0.61) mm. long, 0.20(0.11-0.25) mm. wide, contains seminal vesicle; genital pore opening just under acetabulum; uterus in transverse coils from the extreme posterior end of body to ovary; eggs small, not filamented, 0.017(0.011-0.022) mm. long, 0.011(0.003-0.033) mm. wide; vitelline follicles 17 to 19, oval to pear shaped, grouped between acetabulum and ovary, 0.17(0.10-0.20) mm. long, 0.11(0.10-0.13) mm. wide. Parasites of fish.

SUMMARY

During the months of July and August of 1946, eighteen representative species of the marine fauna of Dillon Beach, California, were examined for helminth parasites. Gregarious hosts were found heavily infected. The trematodes were distributed as follows: Podocotyle elongata in red rock fish (Sebastodes paucispinus); P. californica in viviparous surf fish (Crossochir koelzi); Helicometrina nimia in sculpin (Clinnocottus globiceps); cabezone (Scorpaenichthys marmoratus), and perch (Crossochir koelzi); Genitocotyle acirrus in perch (Crossochir koelzi); sole (unidentified), and zebra perch (Taeniotoca lateralis): hemiurids in blenny (Blennicus sp.) monorchids in jack smelt (Atherinopsis californiensis); Otodistomum cestoides in electric ray (Tetranarce californica); monogenetic trematodes in perch (Crossochir koelzi) and leopard shark (Triakis semifasciatum), Nematodes, cestodes, acanthocephala, parasitic copepods and various larval forms were obtained from animals as indicated in table 1, p.30. Several new trematode hosts are reported. For Genitocotyle acirrus a zebra perch (Taeniotoca lateralis) and a sole;

for Helicometrina nimia a cabezone (Scorpaenichthys marmoratus); for Otodistomum cestoides the electric ray (Tetranarce californica); for Podocotyle elongata a red rock fish (Sebastodes paucispinus);for Podocotyle californica a surf fish (Crossochir koelzi). Descriptions and figures of seven species of trematodes are presented together with observations on possible significances of peculiarities of some structural details hitherto unreported.

TABLE I

Host	No. Examined	No. Infected	Helmin ths
Atherinopsis californiensis	5	5	47 Monorchidae 59 Nematodes 2 Cestodes 31 Larval Helm.
Blennicottus sp.	3	1	68 Hemiurids
Clinocittus globiceps	5	3	3 Unknown 2 *Podocotyle* sp.
Crossochir koelzi	11	11	81 *Genitocotyle acirrus* 1 *Helicometrina nimia* (imm.) 1 *Podocotyle californica* 18 Cestodes 6 Larval Helm.
Haliotis rufrescens	2	1	1 Larval Helm.
Hyperprosopon argenteum	3	3	2 Acanthocephala 1 Monogenetic trematode 3 Nematodes 2 Cestodes 2 Larval Helm.
Leptocottus armatus	4	4	2 Cestodes 2 Acanthocephala 9 Larval Helm.
Platychthys stellatus	3	3	24 Cestodes 10 Acanthocephala 1 Larval Helm.

TABLE I (cont.)

Host	No. Examined	No. Infected	Helminths
Rhinotriacis henlei	2	2	3 Cestodes
Schizotherus nutalli	100	1	Unknown
Sebastodes paucispinus	2	1	1 Podocotyle elongata 1 Larval Helm. 3 Cestodes
Squatina californica	3	0	0
Taeniotoca lateralis	1	1	43 Genitocotyle acirrus
Tetranarce californica	1	1	9 Otodistomum cestoides
Triakis semifasciatum	2	2	61 Monogenetic trematodes 2 Nematodes
Sole Sp. Undetermined	1	1	1 Genitocotyle acirrus 25 Nematodes 40 Cestodes 1 Acanthocephala 43 Larval Helm.
Zalophus californianus	1	1	10 Nematodes 8 Cestodes

EXPLANATIONS OF PLATES

Plate 1.

Drawings of trematodes collected at Dillon Beach. Prepared from photomicrographs of stained whole mounts.

Fig.1. Hemiurid	x 18.5
Fig.2. Podocotyle elongata (Park)	x 44.5
Fig.3. Otodistomum cestoides (Stafford)	x 4.7
Fig.4. Monorchid	x 22.8
Fig.5. Podocotyle californica (Park)	x 80
Fig.6. Helicometrina nimia (Linton)	x 22
Fig.7. Genitocotyle (Park)	x 60

Abbreviations

ac, acetabulum; cs, cirrus sac; ep, excretory pore; es, oesophagus; ev, excretory vesicle; gp, genital pore; gs, genital sucker; hd, hermaphroditic duct; in, intestine; os, oral sucker; ov, ovary; ph, pharynx; pp, pars prostatica; sr, seminal receptacle; sv, seminal vesicle; ts, testes; ut, uterus; vi, vitelline follicles; va, vas deferens; vd, vitelline duct.

Plate 2.

Apparatus

Fig.1. Apparatus used in photographing small trematodes.
Fig.2. Apparatus used in photographing large trematodes.
Fig.3. Rod used for catching various species of blenny underneath rocks.

Plate 3.

Ektachrome photograph of monorchid.

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Plate I.

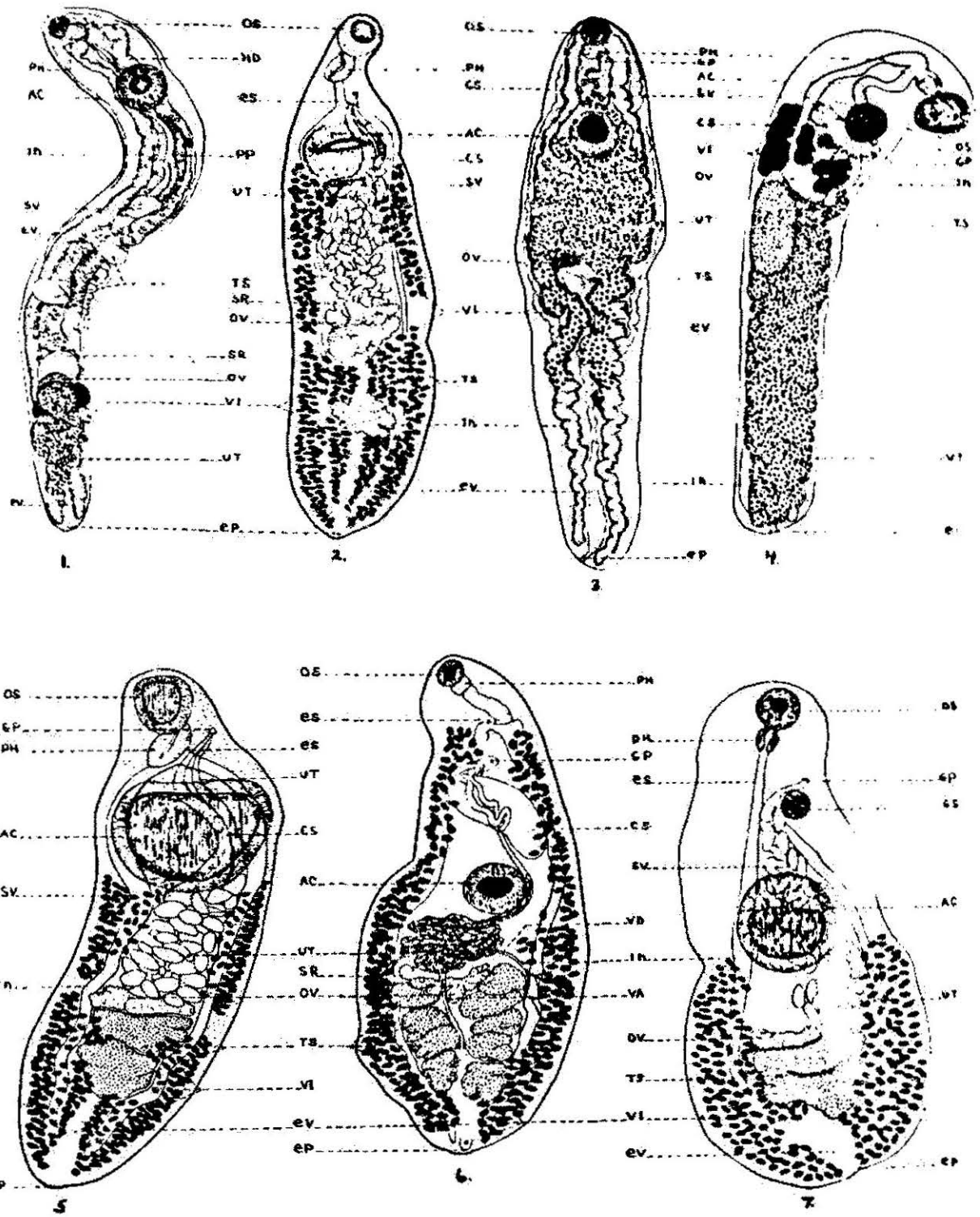
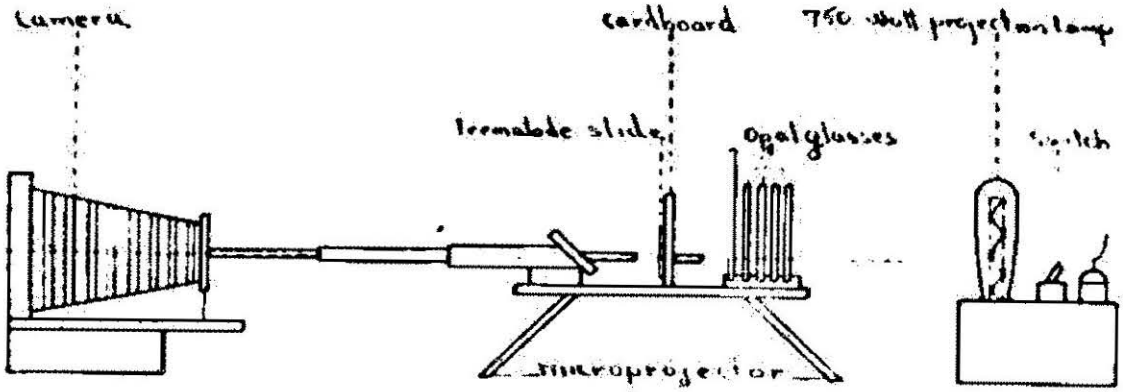
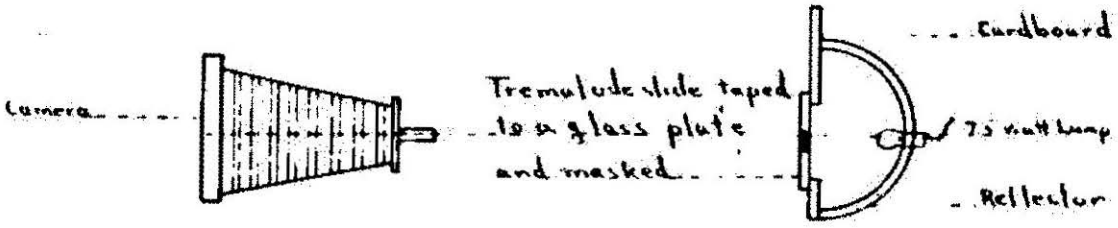


Plate 2



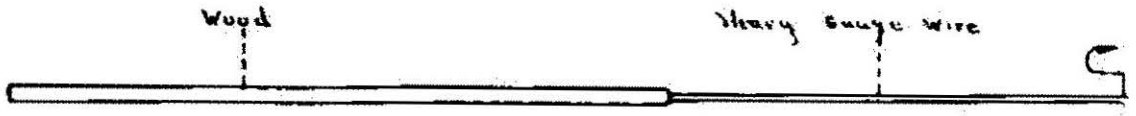
Photomicrographic Equipment For Photographing Trematodes

fig 1



Equipment For Photographing Large Trematodes

fig 2



Bleny Rod

fig 3

Plate 3